El Dorado Hydroelectric Project
FERC Project No. 184

2021 Water Temperature Monitoring Report

EL DORADO IRRIGATION DISTRICT
2890 Mosquito Road
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1.0 INTRODUCTION

The El Dorado Irrigation District (District) owns and operates the El Dorado Hydroelectric Project (Project No. 184 or Project), which is licensed by the Federal Energy Regulatory Commission (FERC). The Project No. 184 Monitoring Program[1] requires water temperature monitoring in stream reaches associated with Project No. 184 facilities. The specific monitoring requirements for water temperature monitoring are defined in the approved Project 184 Water Temperature Monitoring Plan (Plan; EID 2012).

Temperature monitoring is required during spring months to help evaluate breeding conditions for amphibians. Monitoring is also required during summer months to determine if coldwater beneficial uses are being met in designated Project reaches. Therefore, temperature data obtained for selected stream segments during this study will be used to meet the following objectives:

- Characterize the temperature in stream segments by continuously monitoring from April to October;
- Collect and analyze data to determine if water temperatures in the Project area protect coldwater habitat beneficial uses; and,
- Identify any project-controllable temperature resource measures that may be necessary for the protection, mitigation, and enhancement of beneficial uses, if applicable.

The majority of the Project area lies within the South Fork American River (SFAR) drainage, part of the larger Sacramento River Basin. According to the Central Valley Region Basin Plan (CVRWQCB 2011), the designated beneficial uses for this basin include municipal water supply, power supply, contact recreation, non-contact recreation, canoeing and rafting, warm water fish habitat, coldwater fish habitat, coldwater fish spawning, and wildlife habitat. The designated beneficial uses for Lake Aloha, Silver Lake, and Caples Lake include municipal water supply, irrigation, stock watering, industrial process supply, power production, contact recreation, non-contact recreation, warm water and coldwater fish habitat, coldwater fish spawning, and wildlife habitat. Echo Lake and Echo Creek lie within the Lahontan Basin. The designated beneficial uses for these facilities include municipal water supply, groundwater

[1] Section 7 of the El Dorado Relicensing Settlement Agreement, U.S. Forest Service 4(e) Condition No. 37, and California State Water Resources Control Board Section 401 Clean Water Act Water Quality Certification Condition No. 13

recharge, navigation, recreation, commercial and sport fishing, coldwater fisheries, wild trout, and fish spawning (LRWQCB 2005).

Stream flow characteristics in watersheds within the Project area are highly variable due to seasonal variations in both precipitation and air temperature, which result in variations in surface water temperatures. This temperature monitoring program has been designed to provide information regarding water temperature in the vicinity of the Project and identify any project-controllable temperature concerns that can be addressed by project management to protect coldwater beneficial uses.

Monitoring conducted in 2021 represents the thirteenth continuous year of water temperature monitoring performed in accordance with the Plan. Results of the 2021 water temperature monitoring effort are presented herein. 2021 monitoring spreadsheet data (i.e., hourly, daily minimum, daily maximum and mean daily water temperatures) is available online at: http://www.eid.org/our-services/hydroelectric/project-184/project-184-document-library.

2.0 METHODS

2.1 Site Selection

This water temperature monitoring program was designed to monitor surface water temperatures above and below Project diversions throughout the Project area. The current Plan requires continuous recording temperature loggers at various locations from April 1 through October 31, provided safe access was possible. These sites include:

T1	Pyramid Creek downstream of Lake Aloha Dam
T2	Pyramid Creek upstream of South Fork American River
T3	Echo Creek downstream of Echo Lake Dam
T4	Echo Creek upstream of Upper Truckee River
T5	Caples Creek downstream of Caples Lake Dam
T6	Silver Fork American River downstream of Silver Lake Dam
T7	Silver Fork American River upstream of South Fork American River
T8	South Fork American River upstream of Silver Fork Confluence
T9	South Fork American River downstream of Kyburz Diversion
T10	South Fork American River upstream of Powerhouse
T25	South Fork American River at Bridal Veil Picnic Area

In 2021, the District continued monitoring at additional sites not required in the Plan and are located along the South and Silver Fork American River and Caples Creek. These additional monitoring locations are intended to provide information regarding the water temperature characteristics along the length of the Silver Fork American River:

- T26 South Fork American River downstream of the confluence with the Silver Fork American River and upstream of the Kyburz Diversion Dam
- T29 Silver Fork American River near Silver Fork Campground (near Fitch Rantz Bridge)
- T30 Silver Fork American River upstream of the confluence of Caples Creek
- T31 Caples Creek upstream of the confluence with Silver Fork American River

2.2 Temperature Recorders

Two ONSET HOBO Water Temperature Pro V2 Data Loggers were installed at all monitoring locations required in the Plan that could be safely accessed on or before April 1, 2021. Temperature loggers at site T7 were installed on May 20, 2021, when the site was safely accessible following snowmelt. All other loggers were installed before the April 1, 2021, temperature recording start date.

All temperature loggers were programmed to record water temperature at 1-hour intervals, 24-hours per day. At each location, one recorder was designated as logger A and the second as logger B, and the two loggers were deployed immediately adjacent to each other for redundancy purposes in the event one logger failed to record accurately. The loggers were housed in protective copper sleeves and secured to the stream bank using stainless steel cable. Data were downloaded from recorders twice during the monitoring period using a HOBO waterproof data shuttle and/or transferred to a laptop computer. Temperature loggers that were safely accessible were removed in late October or early November with the exception of T29, T30, and T31 as described in Section 3.3.

2.3 Data Analysis

Hourly data were downloaded using HOBOware Pro software from which daily maximum, minimum, and mean temperatures were calculated. Data were

exported and compiled using Microsoft Excel. Daily maximum, minimum, and mean temperatures for the each recorder deployed at a given location were compared graphically for anomalies. If data anomalies were observed for one recorder, then data from the other recorder were used in the analysis. When no data anomalies were present, the data from logger A were used in the analysis.

The thermal preference literature for salmonids (trout and salmon) is vast and widely variable depending upon genetic race of fish, acclimation temperatures, oxygen levels, food supply, and myriad other factors (McCullough 1999, Myrick and Cech 2004, Mathews and Berg 1997, Kupferberg et al. 2009). Based on this information, the generalized criteria for evaluating water temperatures for trout and other coldwater species including amphibians in this report is provided in Table 1.

Table 1. Criteria for evaluating water temperatures for trout and other coldwater species including amphibians in this report

Mean Daily Water Temperatures	Coldwater Species Response
< 20 °C	Optimal growth and survival
20 - 23 °C	Suitable; increased susceptibility to stressors
>23 - 26 °C	Physiological stress and behavioral shifts to compensate
> 26 °C	Adverse effects and potential mortality

3.0 RESULTS AND DISCUSSION

Results of 2021 temperature monitoring are summarized below for each monitoring location along with a general description of characteristics associated with each location. Figures showing the daily mean, maximum, and minimum water temperatures are presented in Appendix A. Daily Mean, maximum and minimum water temperatures are provided in electronic format in Appendix B.

3.1 Pyramid Creek (T1 & T2)

Pyramid Creek is a south-facing watershed located along the east side of the Sierra Nevada crest. Pyramid Creek flows out of Lake Aloha and is the highest elevation watershed monitored in this study. T1 is located in Pyramid Creek in the outflow channel just below the dam at Lake Aloha. T2 is located in Pyramid Creek upstream of the Highway 50 crossing. Logger A data was used for both sites.

Daily mean water temperatures at T1 and T2 are shown in Figure 2. Figure 3 shows the daily maximum and minimum water temperatures at T1. Figure 4 shows the daily maximum and minimum water temperatures at T2.

Water temperatures recorded in Pyramid Creek at water temperature monitoring sites T1 and T2 were within the optimal and suitable range for trout and other coldwater species, including amphibians throughout the monitoring period. No anomalies were recorded.

3.2 Echo Creek (T3 & T4)

Echo Creek flows out of the southeast end of Echo Lake and into the Upper Truckee River near the town of Myers, CA. This east-facing watershed is the only watershed in the Project area that is not within the American River drainage. T3 is located near the Echo Creek gage station approximately 100 meters downstream of the Echo Lake Dam. T4 is located upstream of the confluence with the Upper Truckee River near the town of Myers. Logger A data was used for both sites.

Daily mean water temperatures at T3 and T4 are shown in Figure 5. Figure 6 shows the daily maximum and minimum water temperatures at T3. Figure 7 shows the daily maximum and minimum water temperatures at T4.

Water temperatures recorded in Echo Creek at monitoring sites T3 and T4 were within the optimal and suitable range for trout and other cold water species, including amphibians throughout the monitoring period. No anomalies were recorded.

3.3 Silver Fork American River Watershed (T5, T6, T30, T31, T29, & T7)

The Silver Fork American River watershed is the largest tributary in the Project area. This north-facing watershed near the Sierra Nevada crest includes Caples Lake, Kirkwood, and Silver Lake drainages located between the South Fork American and Mokelumne watersheds. T5 is located in Caples Creek near the gage station below Caples Lake Dam. T6 is located in the Silver Fork American River (Silver Fork) downstream of Silver Lake Dam. T31 is located in Caples Creek upstream of the footbridge near the confluence with the Silver Fork. T30 is located in the Silver Fork upstream of the confluence with Caples Creek near Forgotten Flat. T29 is located in the Silver Fork near Silver Fork Campground

(near Fitch Rantz Bridge) downstream of the Caples Creek confluence. T7 is located in the Silver Fork upstream from the confluence with the SFAR.

Temperature loggers located at T29, T30, and T31 were not collected due to hazardous conditions as a result of the Caldor Fire. The Eldorado National Forest, including Mormon Emigrant Trail, have been under a closure order since August 17th and is scheduled to remain closed through March 31, 2022. This report will be updated and include the data sets from T29, T30, and T31 after these locations are accessible, which is anticipated to occur in the spring of 2022.

Logger A data was used for sites T5, T6, and T7. Both temperature loggers located at T6 were displaced from the water and exposed to the atmosphere after the late October 2021 storm event resulting in significant temperature variations above and below typical water temperatures recorded for this site. The temperature loggers at T7 were deployed on May 20, 2021 after the site was safely accessible. Daily mean water temperatures at T5, T6, and T7 are shown in Figure 8. The daily maximum and minimum water temperatures at T5, T6, and T7 are shown in Figures 9-14.

Daily maximum temperatures at T7 in the Silver Fork upstream of the SFAR confluence exceeded 23°C from July 4 through July 13, 2021. The region was experiencing a heatwave and local temperatures exceeded 100°F over multiple days. The National Weather Service Sacramento issued an Excessive Heat Warning for dangerous heatwave starting Friday, July 9, 2021, through Monday, July 12, 2021. Water temperatures exceeding the suitable range were also recorded in the SFAR during this extreme weather event and will be discussed in section 3.4. Elevated daily maximum water temperatures have been recorded at this site in the past due to the loggers being exposed to shallow water during the summer. This segment of the water course has multi-threaded channels that branch out before merging with the SFAR. Since flows are typically much higher in the spring when the loggers are deployed, the loggers are installed near the bank for safety purposes. As flows recede in the summer, the initial installation site may no longer provide representative data of water temperatures in this reach. The District plans to monitor the position of the logger during the monitoring season and may relocate the loggers during the monitoring season to ensure the temperature data collected is representative of the majority of flow in the channel in the Silver Fork. With the exception 9-day period during the July heatwave, water temperatures at T7 were within the optimal and suitable range for coldwater species for the monitoring period.

Water temperatures recorded in the upper watershed at sites T5 and T6 were within the optimal and suitable ranges for trout and other coldwater species, including amphibians throughout the monitoring period.

3.4 South Fork American River (T8, T26, T9, T25, and T10)

The SFAR drains the west side of the Sierra Nevada and is the mainstem river within the Project area. T8 is located approximately 0.5 miles upstream of the Kyburz Diversion, upstream of the Silver Fork confluence, and is the upstream-most monitoring location in the mainstem of the SFAR. T26 is located immediately upstream of the Kyburz Diversion and downstream of the Silver Fork confluence. T9 is located downstream of the Kyburz Diversion. T25 is located east of the Bridal Veil Picnic Area in the middle of the Project reach. T10 is located at the downstream end of the Project area, upstream of the Akin Powerhouse. Logger A data was used for sites T9 and T10 and logger B data was used for sites T8, T25, and T26 because the logger A at these sites were dislodged and not recovered. Additionally, logger B at site T25 was also dislodged after the July data reading event and was not recovered. Consequently T25 temperatures were recorded from April 1st through July 11th. The District will select a new anchor point for the temperature loggers at the T25 location for upcoming monitoring events.

Daily mean water temperatures in the SFAR (sites T8, T26, T9, T25, and T10) are shown in Figure 15. Figure 16 shows the daily maximum and minimum water temperatures in the SFAR above the Silver Fork confluence at T8. Figure 17 shows the daily maximum and minimum water temperatures in the SFAR above the Kyburz Diversion at T26. Figure 18 shows the daily maximum and minimum water temperatures in the SFAR below the Kyburz Diversion Dam at T9. Figure 19 shows the daily maximum and minimum water temperatures in the SFAR near the Bridal Veil Picnic Area at T25. Figure 20 shows the daily maximum and minimum water temperatures in the SFAR upstream of the Akin Powerhouse at T10.

As in the past years of monitoring, the SFAR water temperatures increased with the approximate 2,100 foot drop in elevation from T8 to T10. Water temperatures at T8, T26, and T9 were within the optimal and suitable range for coldwater species for the duration of the monitoring period with the exception of the four days from July 10 to July 12 when the region was experiencing an extreme heatwave as cited in section 3.3. There was no increase of water temperatures

between T8 above the Kyburz Diversion/Silver Fork and T9 below the Kyburz Diversion during this extreme weather event. Water temperatures in the middle (T25) and lower (T10) reaches of the Project were appropriate for the warmer water transitional species assemblage present in this reach (Moyle 2002).

Using hourly data, the average temperature difference above and below the Kyburz Diversion (between T26 and T9) was 0.01°C warmer below during the monitoring period. The maximum difference in temperature during this timeframe was 0.6°C, measured during four consecutive days from September 21 to September 24, 2021, during which time the District was not diverting water at the Kyburz Diversion facility. Maximum monthly temperature differences between T26 and T9 and the number of hourly readings when the maximum temperature difference was observed are provided in Table 2.

Table 2. Temperature Difference above and below the Kyburz Diversion (between T26 and T9) from July to October 2021

Month	Maximum temperature difference (°C)	Number of hourly readings maximum temperature difference was observed*
July	0.4	6
August	0.5	3
September	0.6	5
October	0.4	13

*Total number of hourly readings during the monitoring period n=5,138

4.0 CONCLUSION

Overall, water temperatures measured in the Project area were within the optimal and suitable range for trout and other coldwater species, including amphibians throughout the study period.

Water temperatures in the middle (T25) and lower (T10) reaches of the Project area warm naturally at lower elevations. The upper reaches of the Project area support cold water species assemblages (e.g., rainbow trout assemblage; Moyle 2002), while the middle and lower reaches are grading into warmer water, and

have a transitional species assemblage (pikeminnow-hardhead-sucker assemblage) reflective of this natural change and incrementally warmer water caused by higher ambient air temperatures.

5.0 REFERENCES

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Mathews, K., and N. Berg. 1997. Rainbow Trout Responses to Water Temperature and Dissolved Oxygen Stress in Two Southern California Stream Pools. Journal of Fish Biology 50, 50-67.

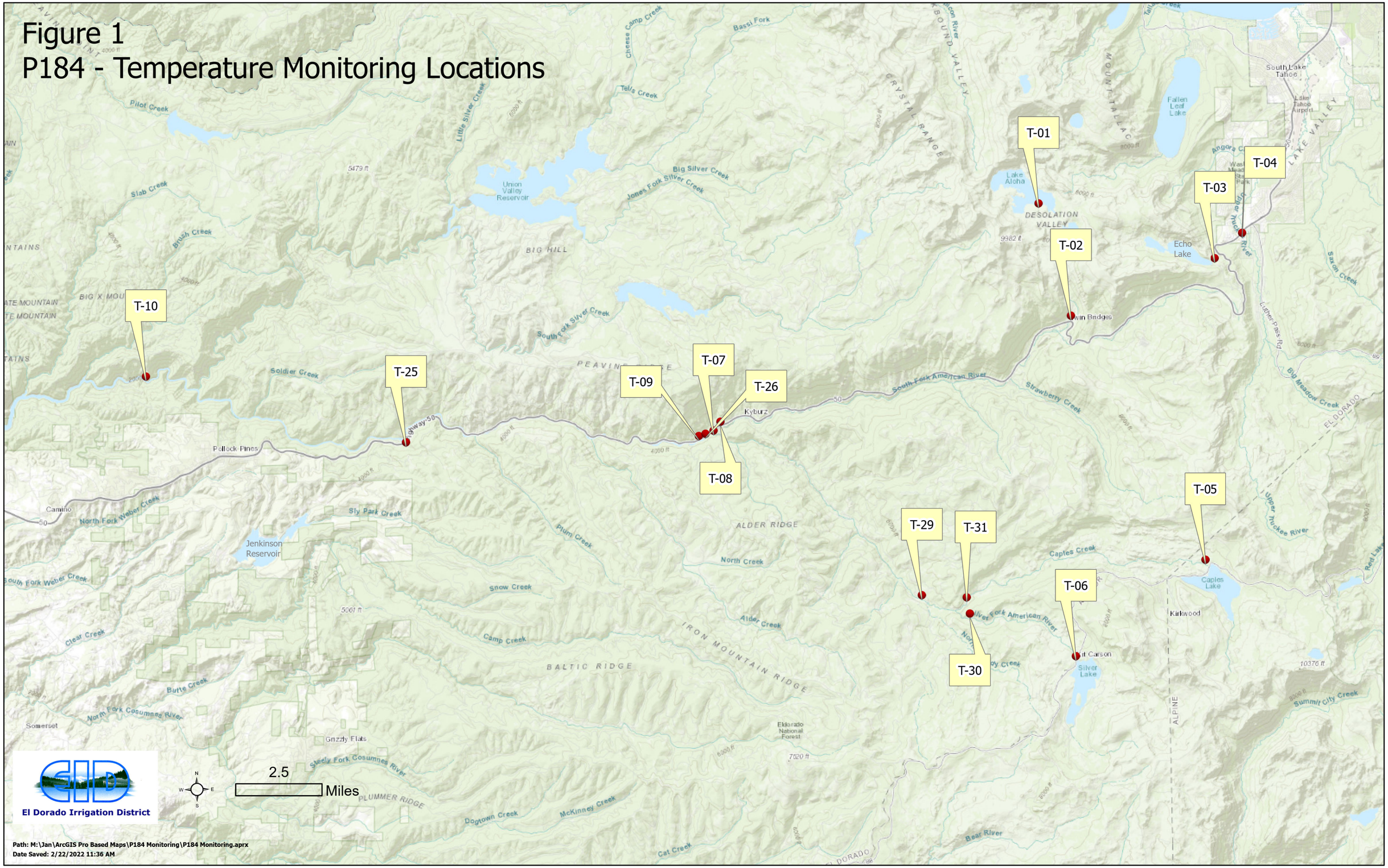
McCullough, D. 1999. A Review and Synthesis of Effects of Alterations to the Water Temperature Regime on Freshwater Life Stages of Salmonids, with Special Reference to Chinook Salmon. EPA 910-R-99-010. U.S. Environmental Protection Agency, Portland OR. 279 pp.

Moyle, P. B. 2002. Inland Fishes of California. Second Edition. University of California Press. Berkeley. 502 pp.

Myrick, C., and J. Cech Jr. 2004. Temperature Effects on Juvenile Anadromous Salmonids in California's Central Valley: What Don't We Know. Reviews in Fish Biology and Fisheries 14: 113-123.

Appendix A:
Figures

Figure 1
P184 - Temperature Monitoring Locations



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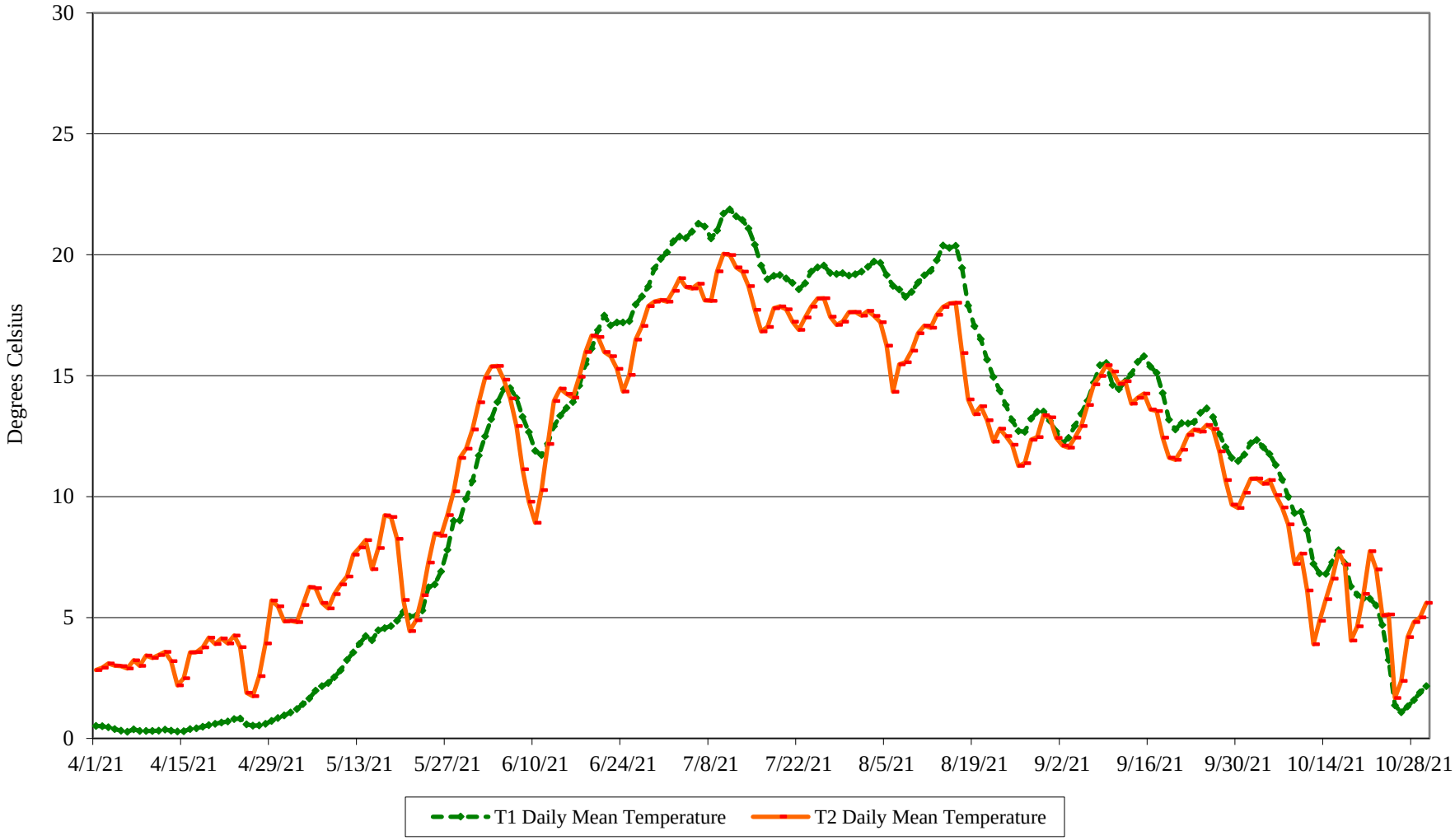

Figure 2. Daily Mean Water Temperatures in Upper and Lower Pyramid Creek (T1 & T2).

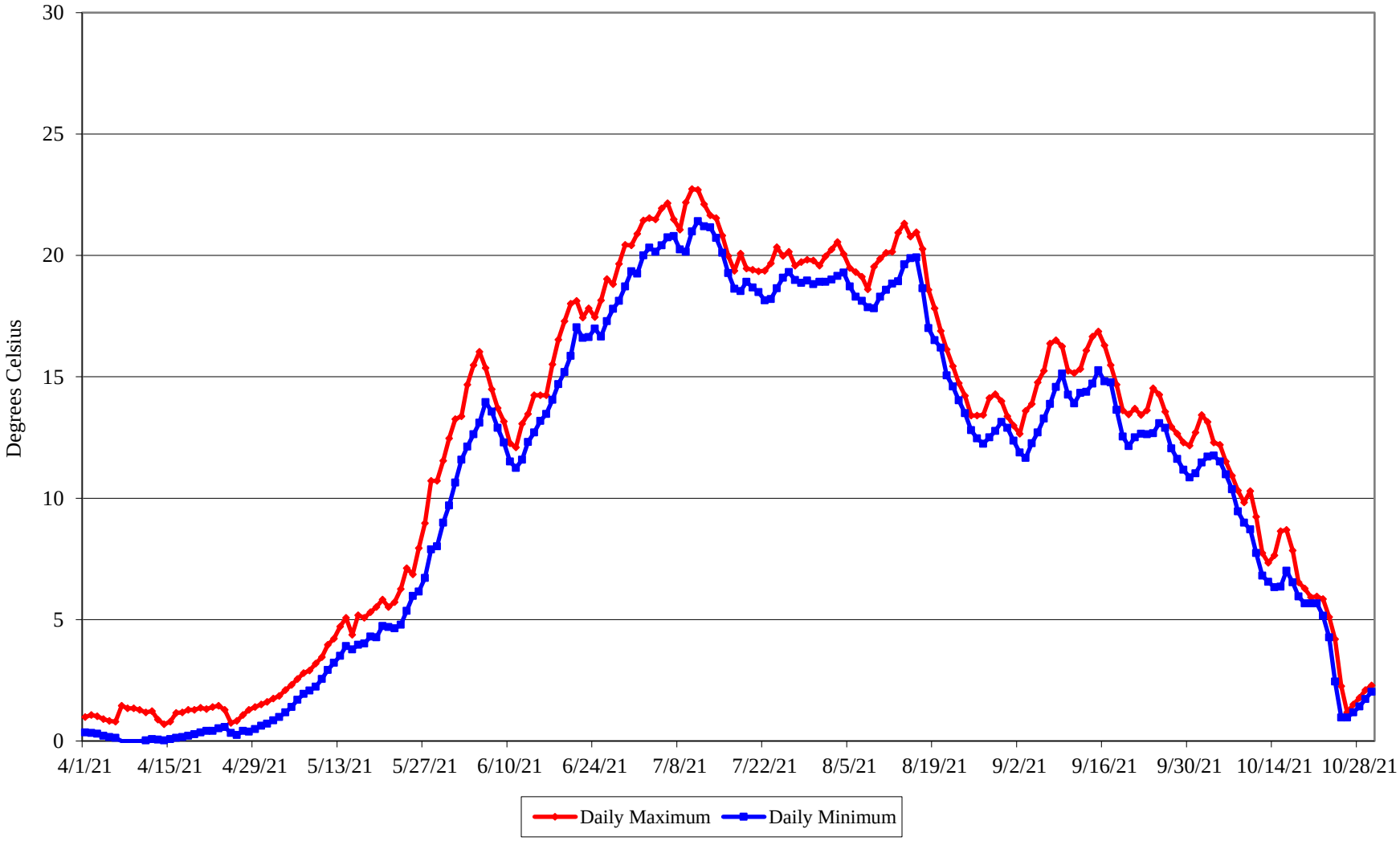

Figure 3. Daily Maximum and Minimum Water Temperatures in Upper Pyramid Creek (T1)

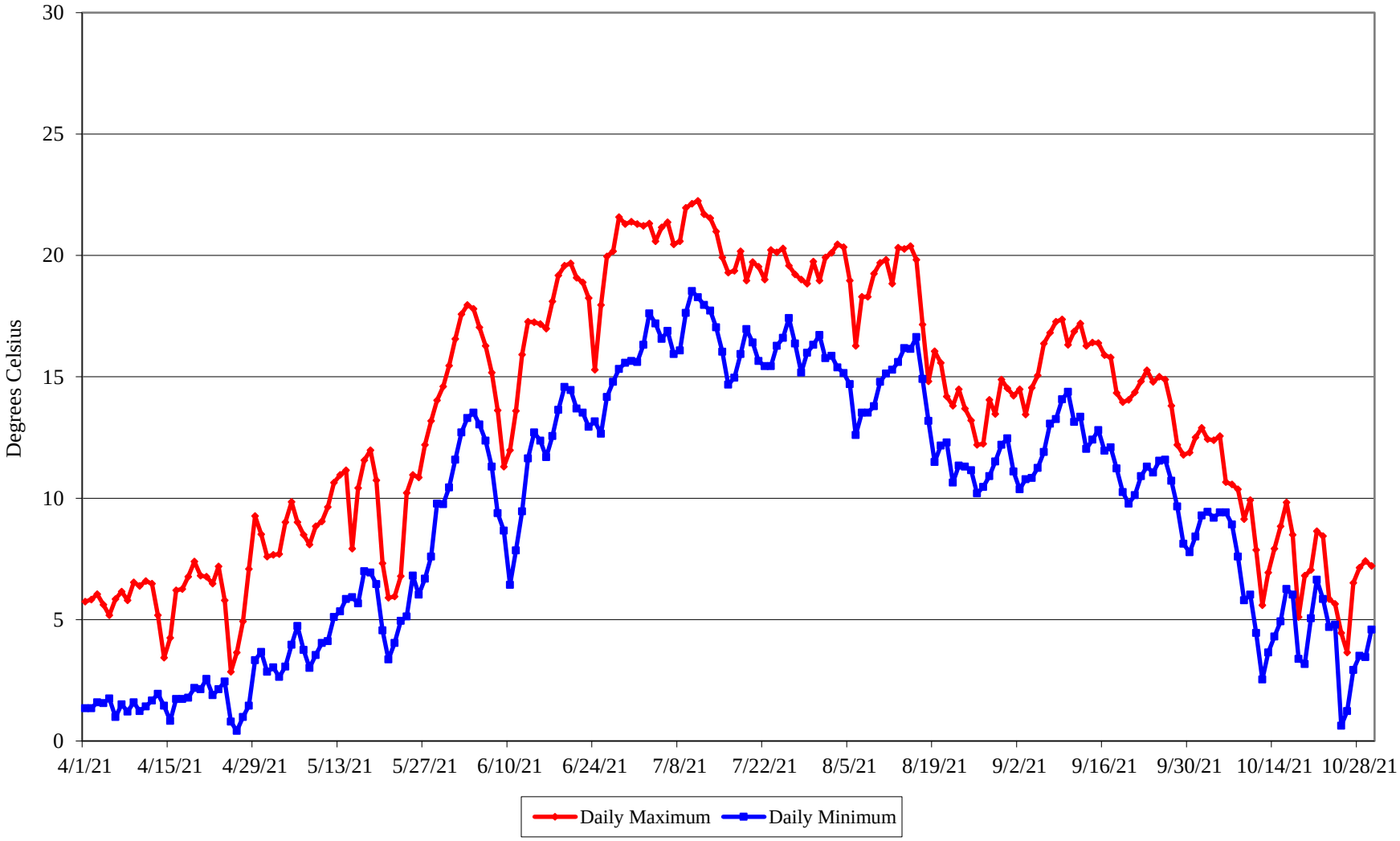

Figure 4. Daily Maximum and Minimum Water Temperatures in Lower Pyramid Creek (T2)

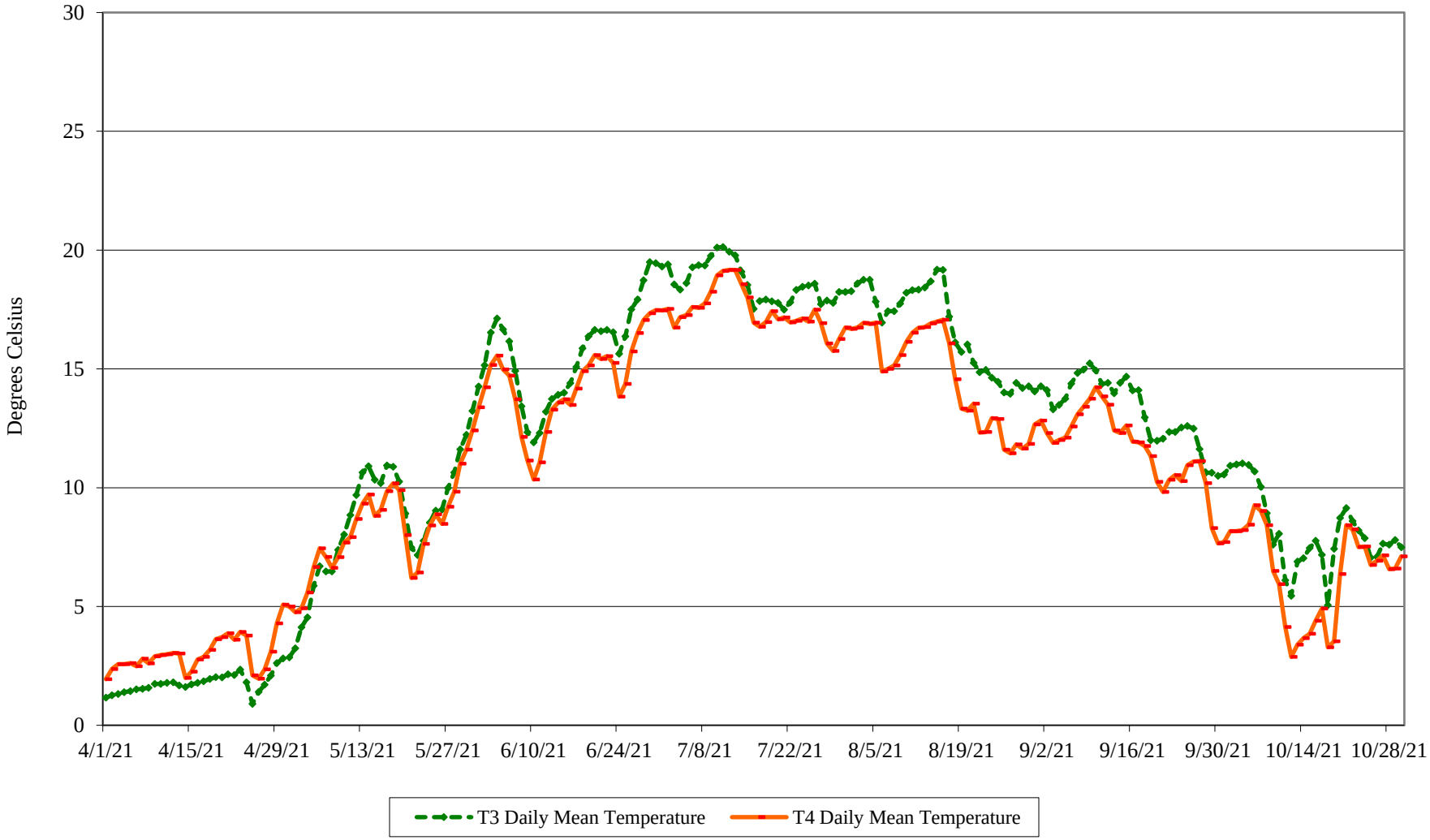

Figure 5. Daily Mean Water Temperatures in Upper and Lower Echo Creek (T3 & T4)

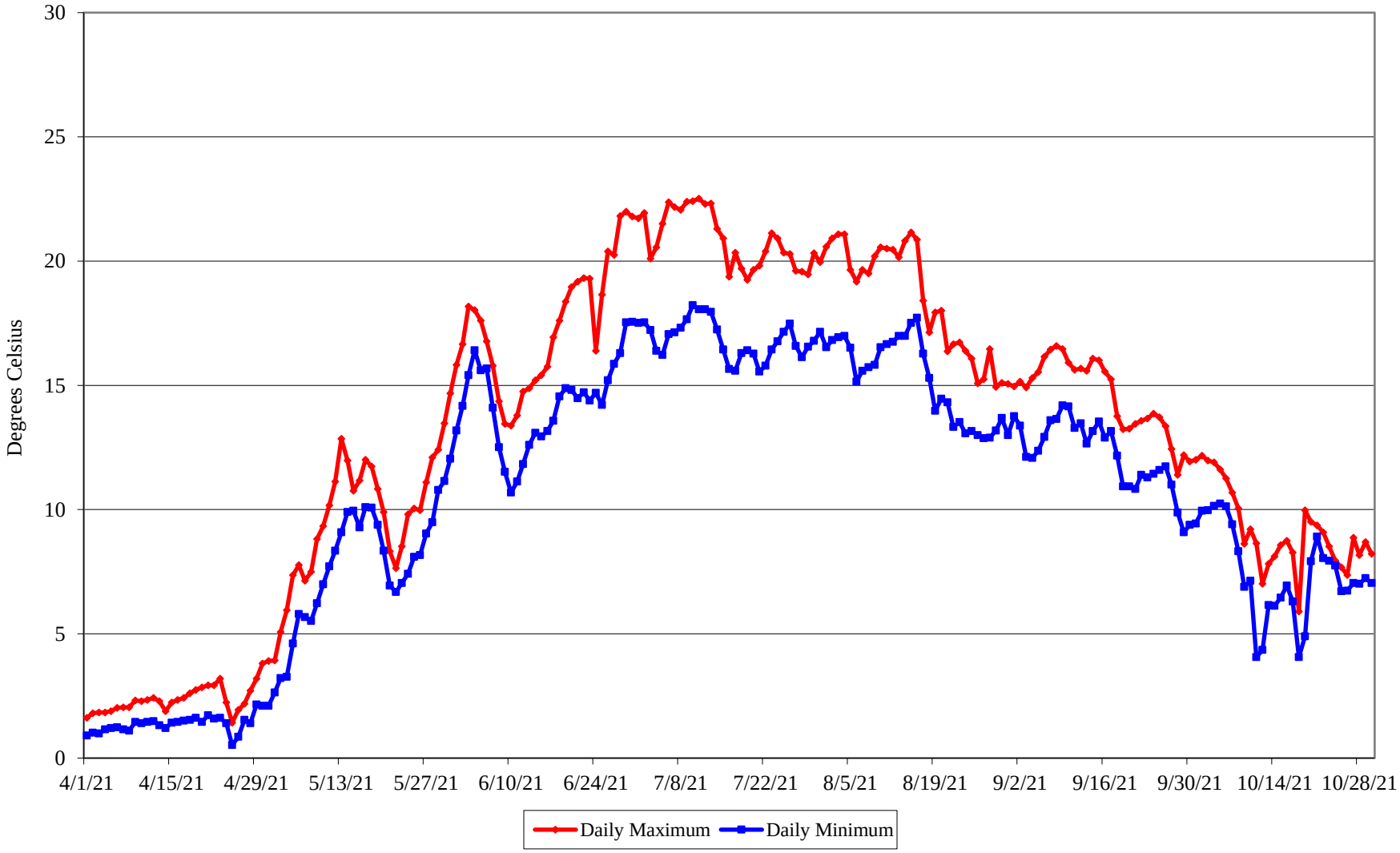

Figure 6. Daily Maximum and Minimum Water Temperatures in Upper Echo Creek (T3)

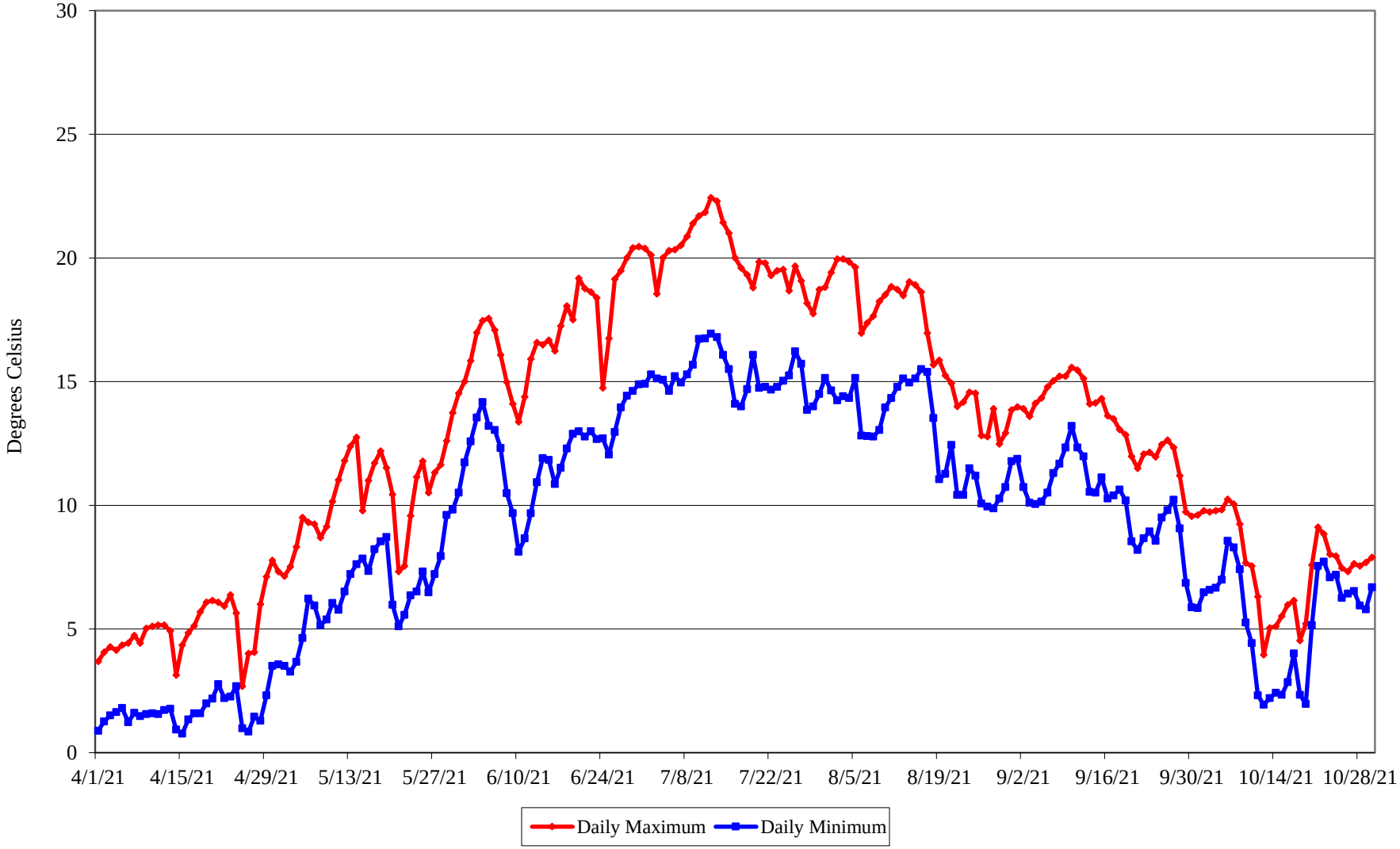

Figure 7. Daily Maximum and Minimum Water Temperatures in Lower Echo Creek (T4)

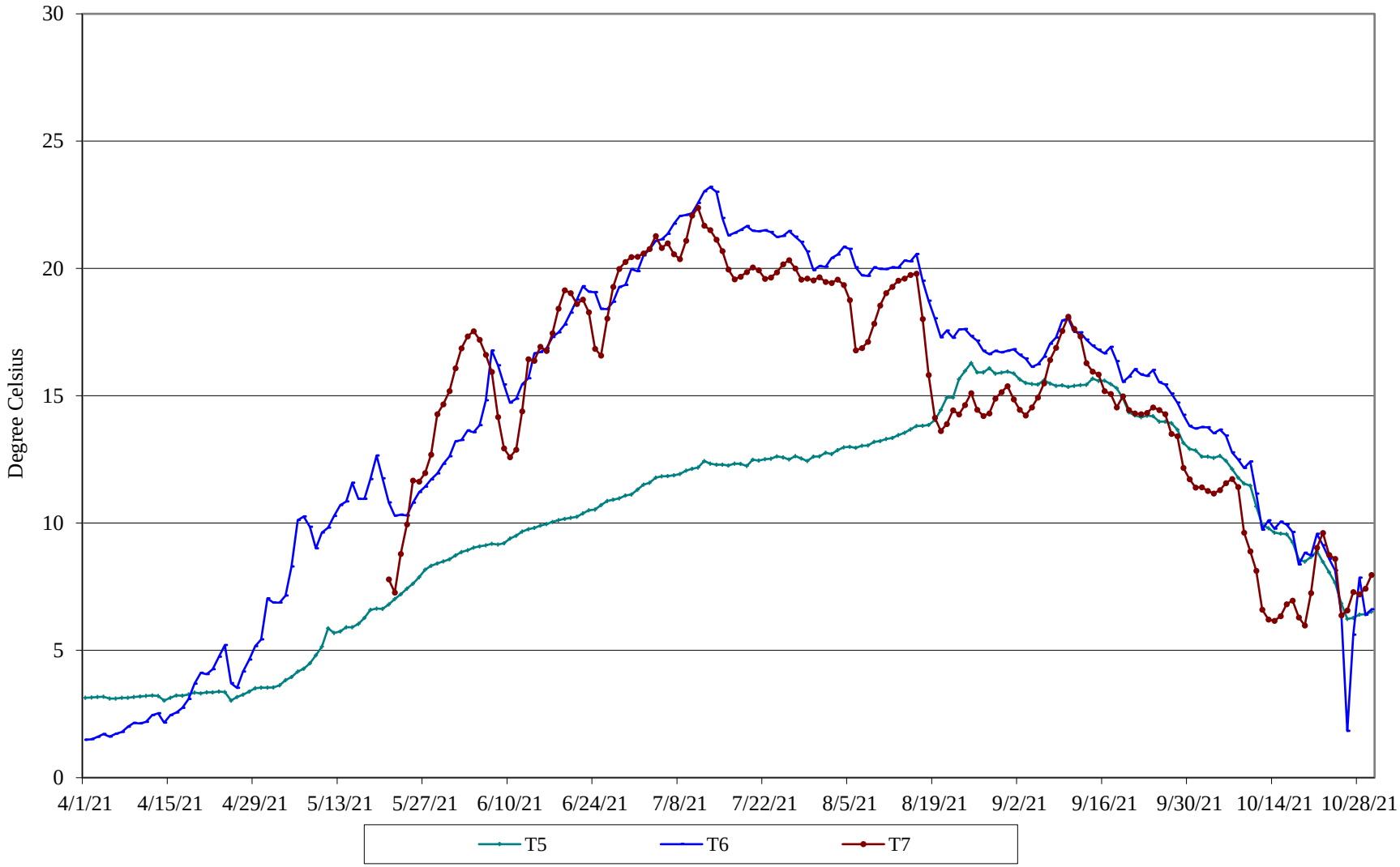

Figure 8. Daily Mean Water Temperatures in Silver Fork American River and Caples Creek (T5, T6, & T7)

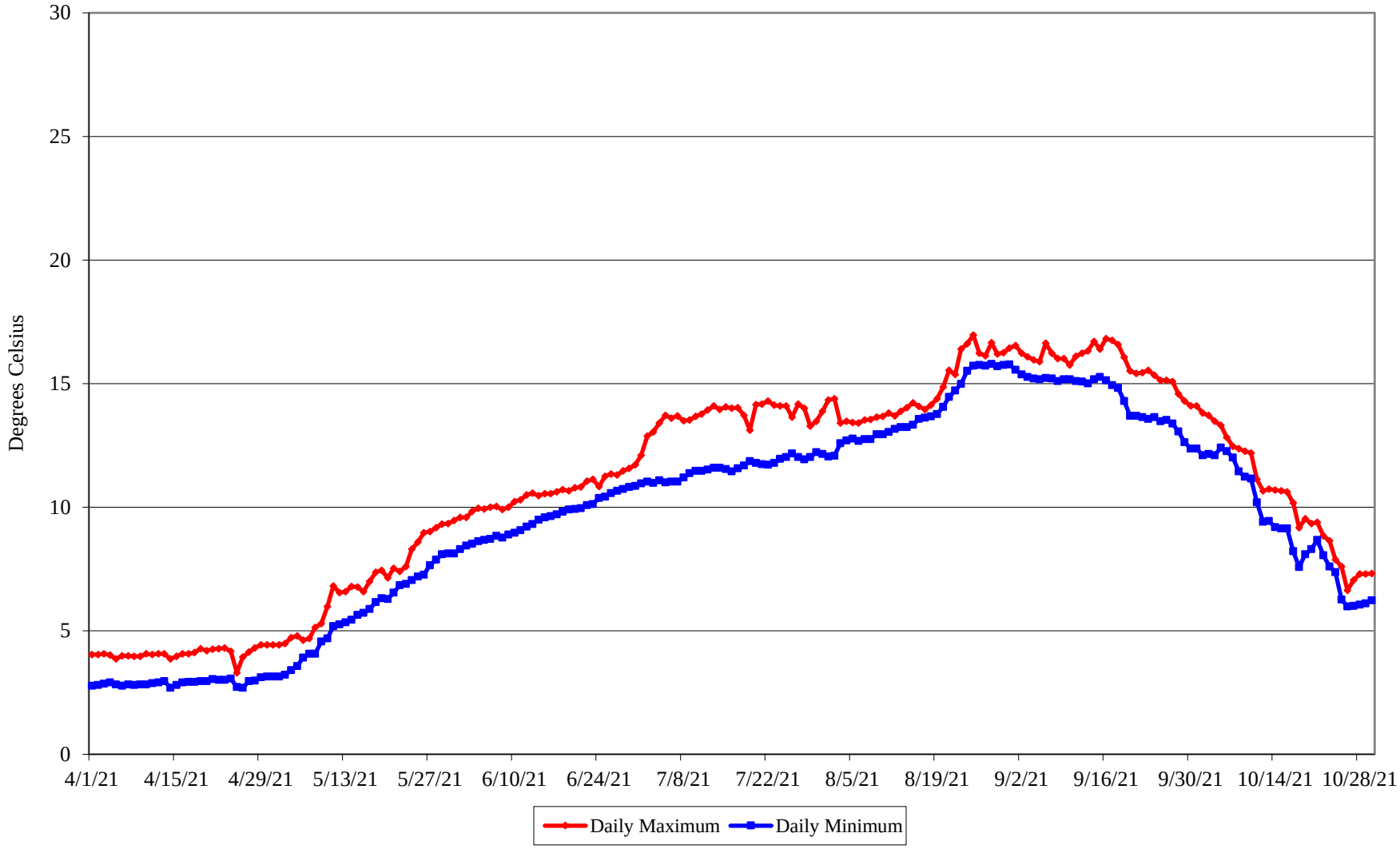

Figure 9. Daily Maximum and Minimum Water Temperatures in Caples Creek (T5)

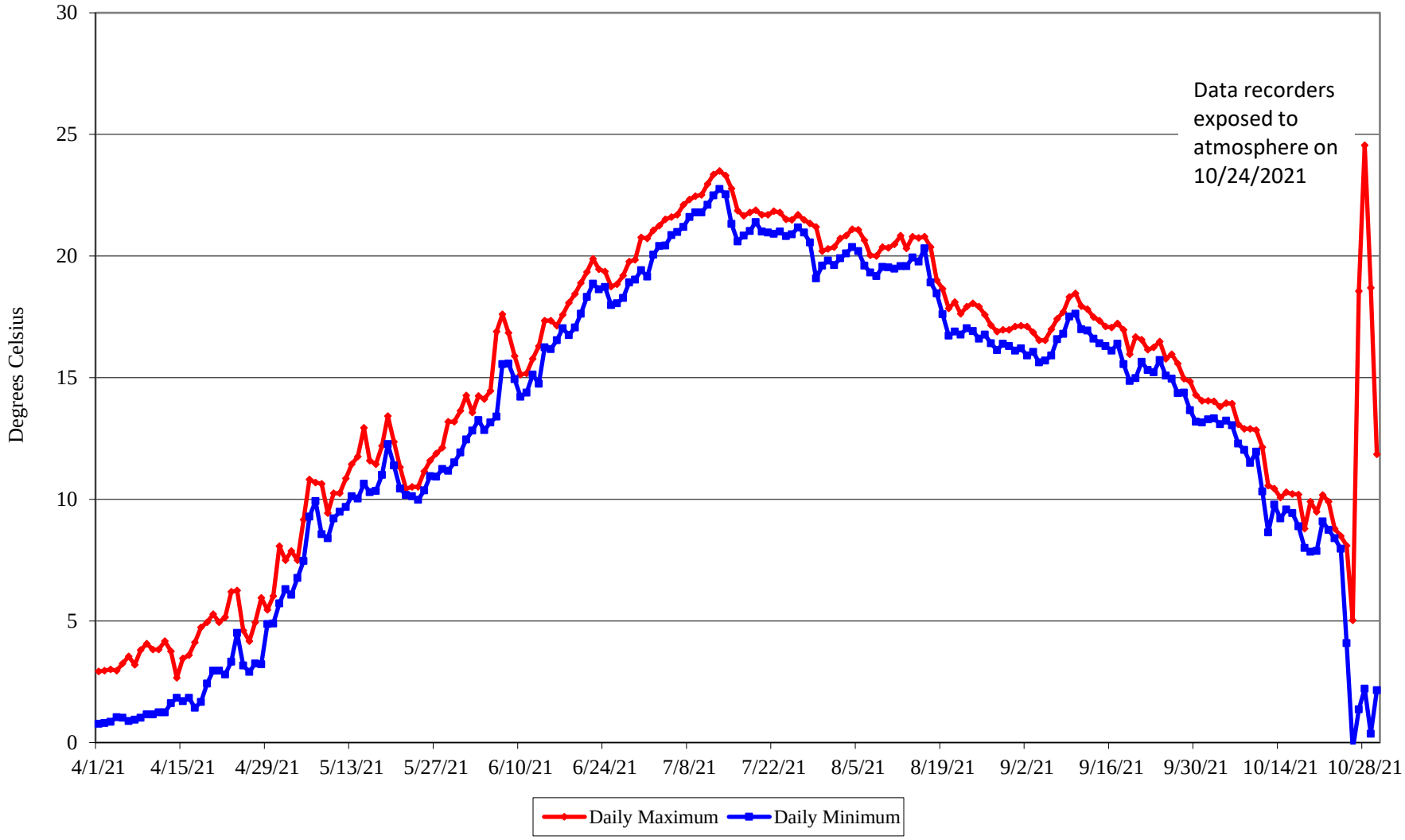

Figure 10. Daily Maximum and Minimum Water Temperatures in Upper Silver Fork American River (T6)

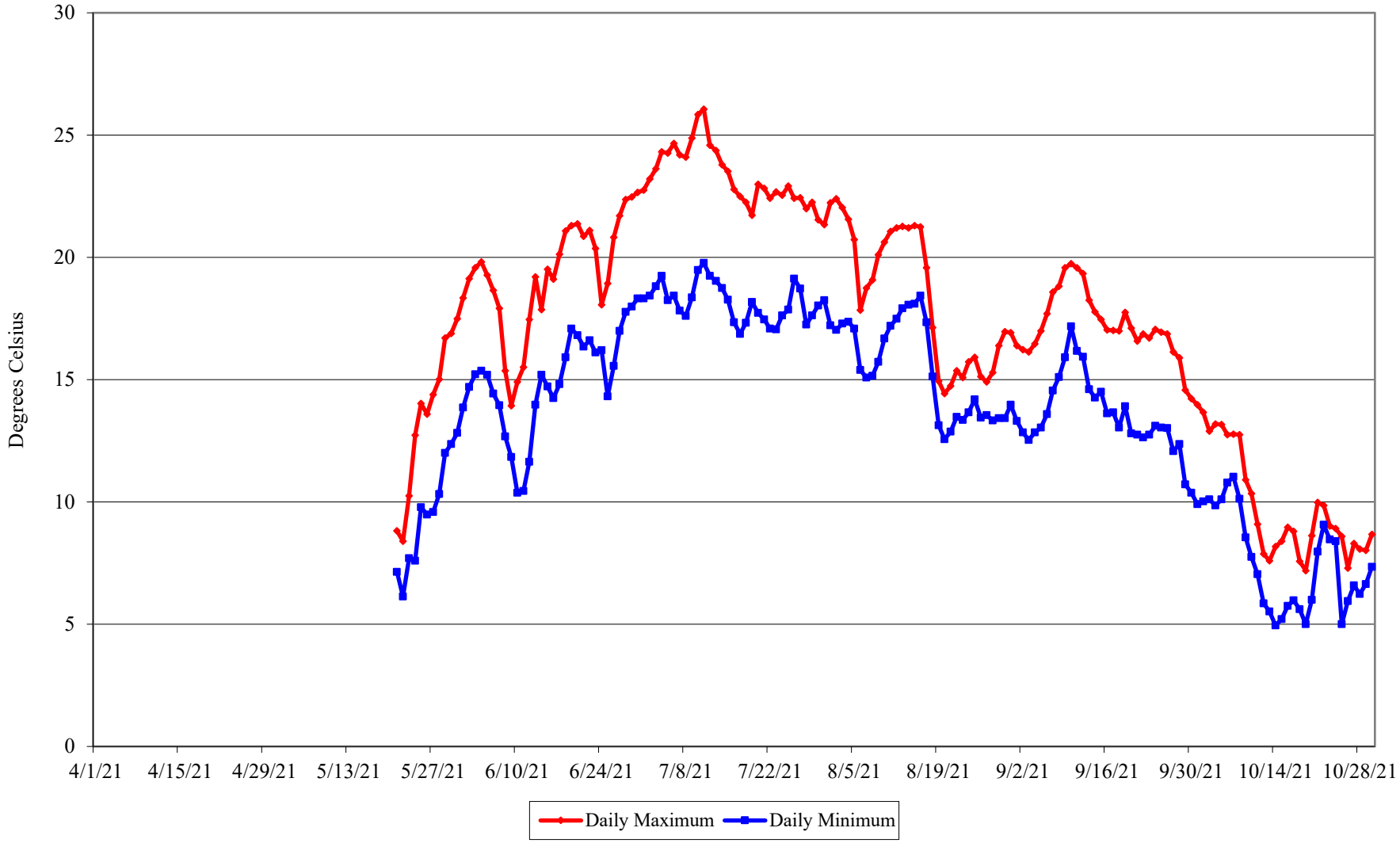

Figure 11. Daily Maximum and Minimum Water Temperatures in Lower Silver Fork American River (T7)

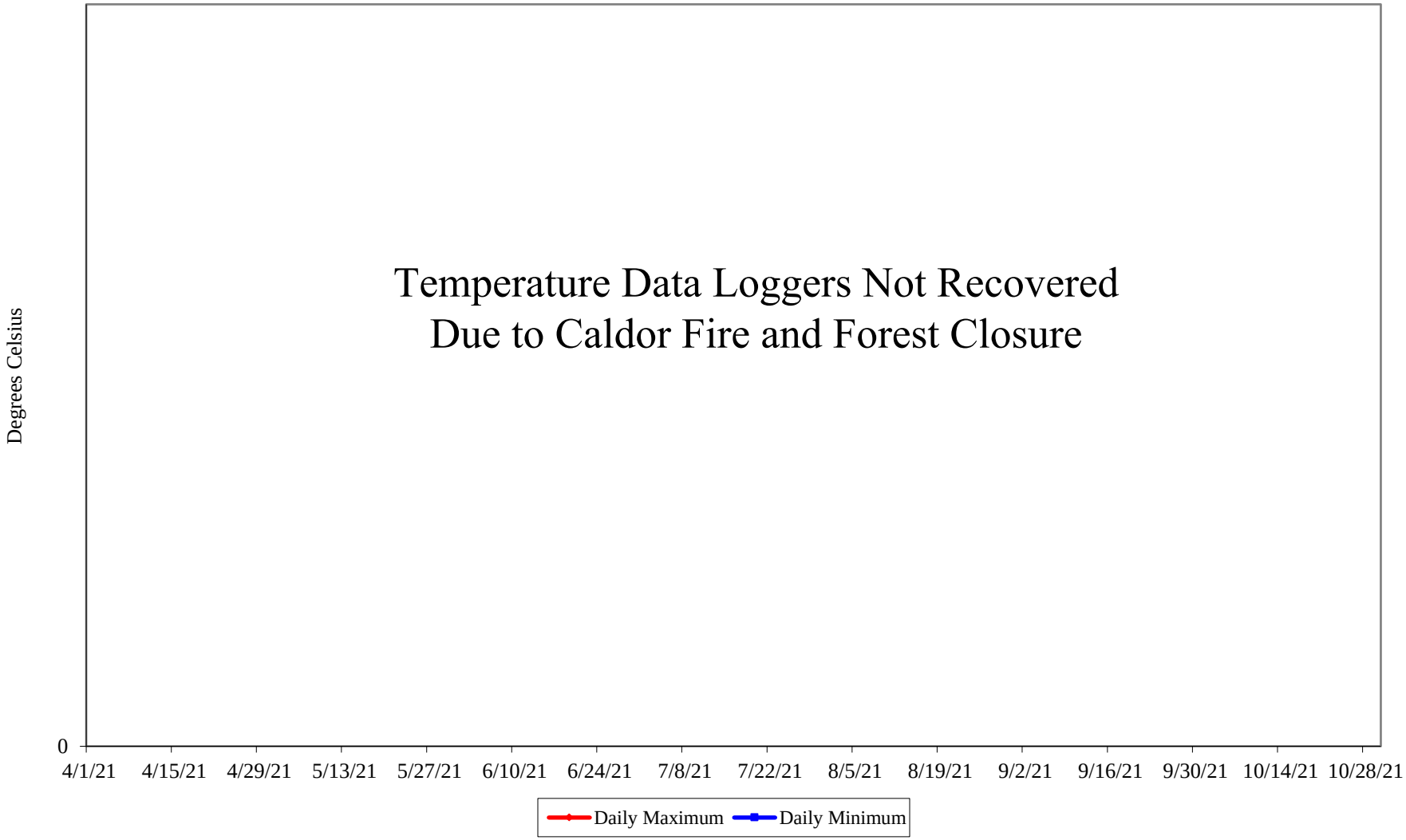

Figure 12. Daily Maximum and Minimum Water Temperatures in Silver Fork American River near Fitch Rantz Bridge (T29)

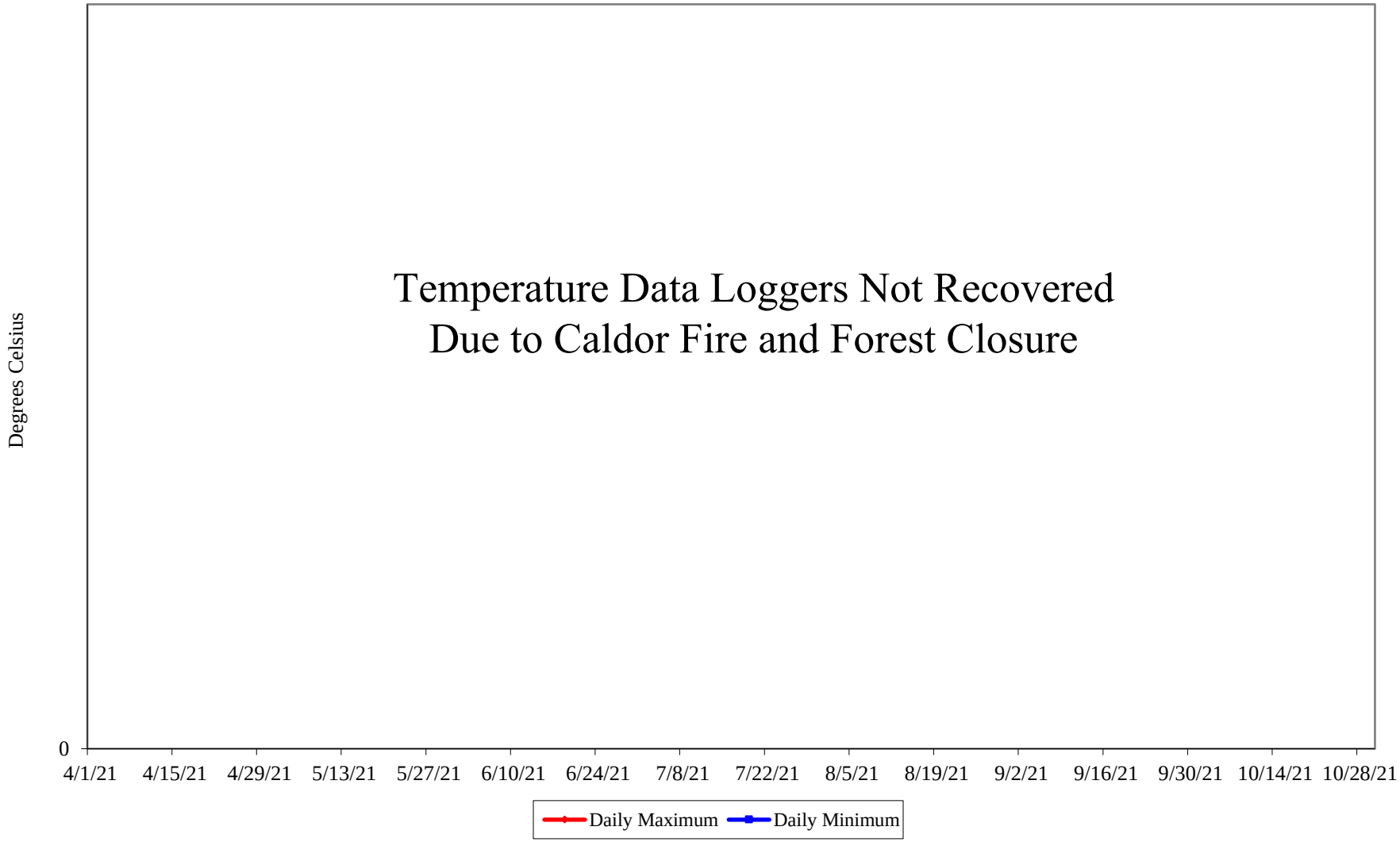

Figure 13. Daily Maximum and Minimum Water Temperatures in
Silver Fork American River upstream of Caples Creek (T30)

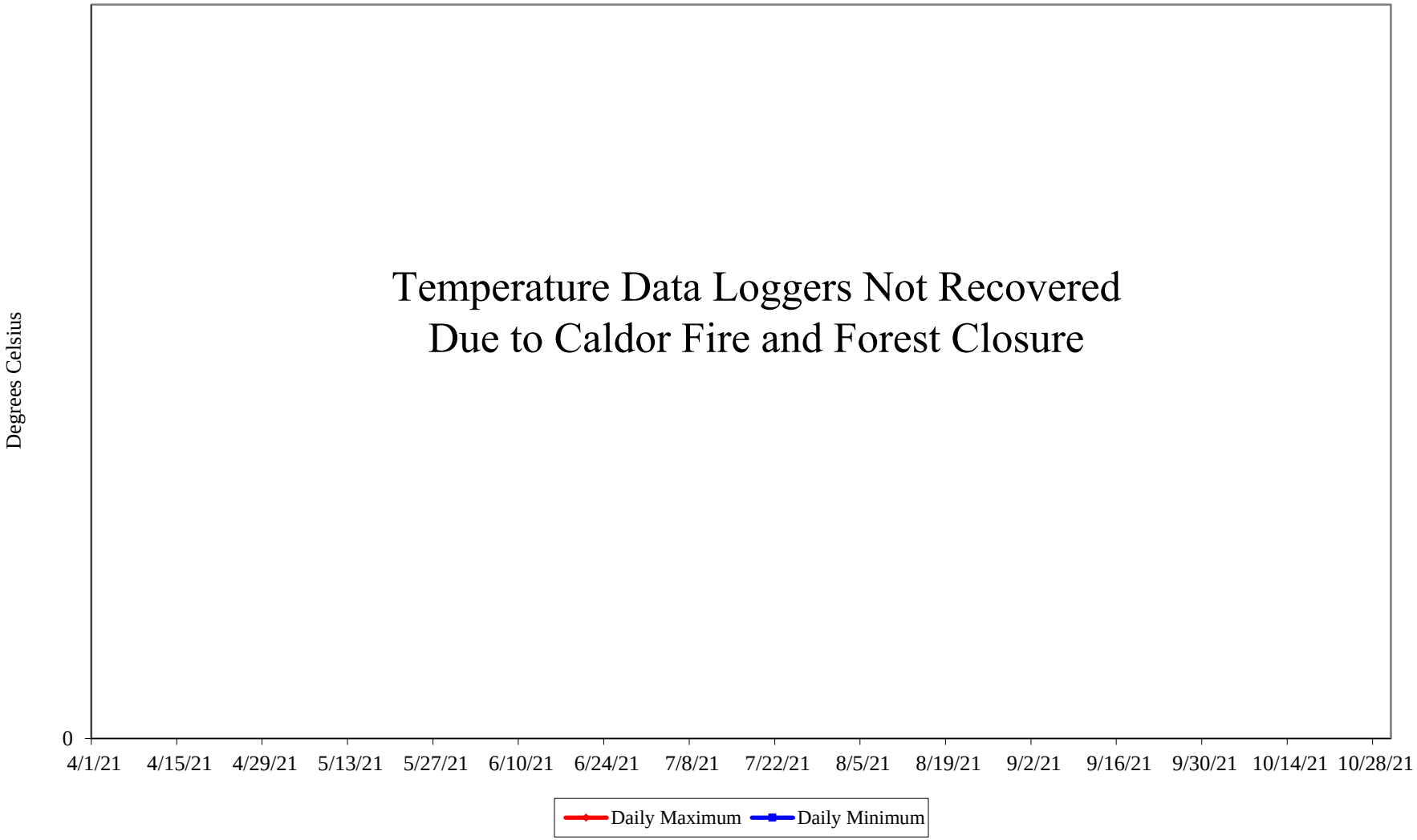

Figure 14. Daily Maximum and Minimum Water Temperatures in Caples Creek Upstream of Silver Fork American River (T31)

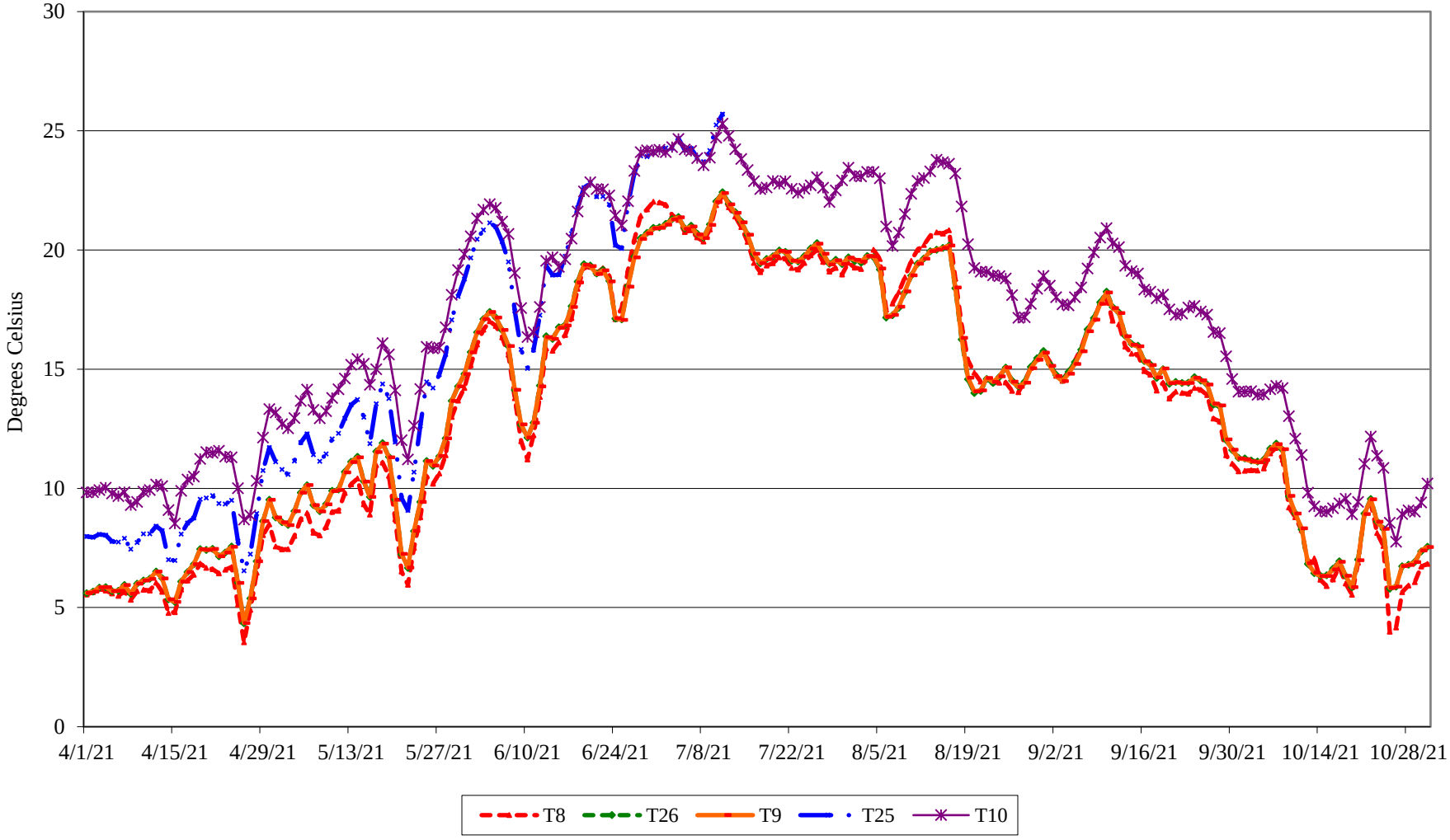

Figure 15. Daily Mean Temperature in South Fork American River (T8, T26, T9, T25, & T10)

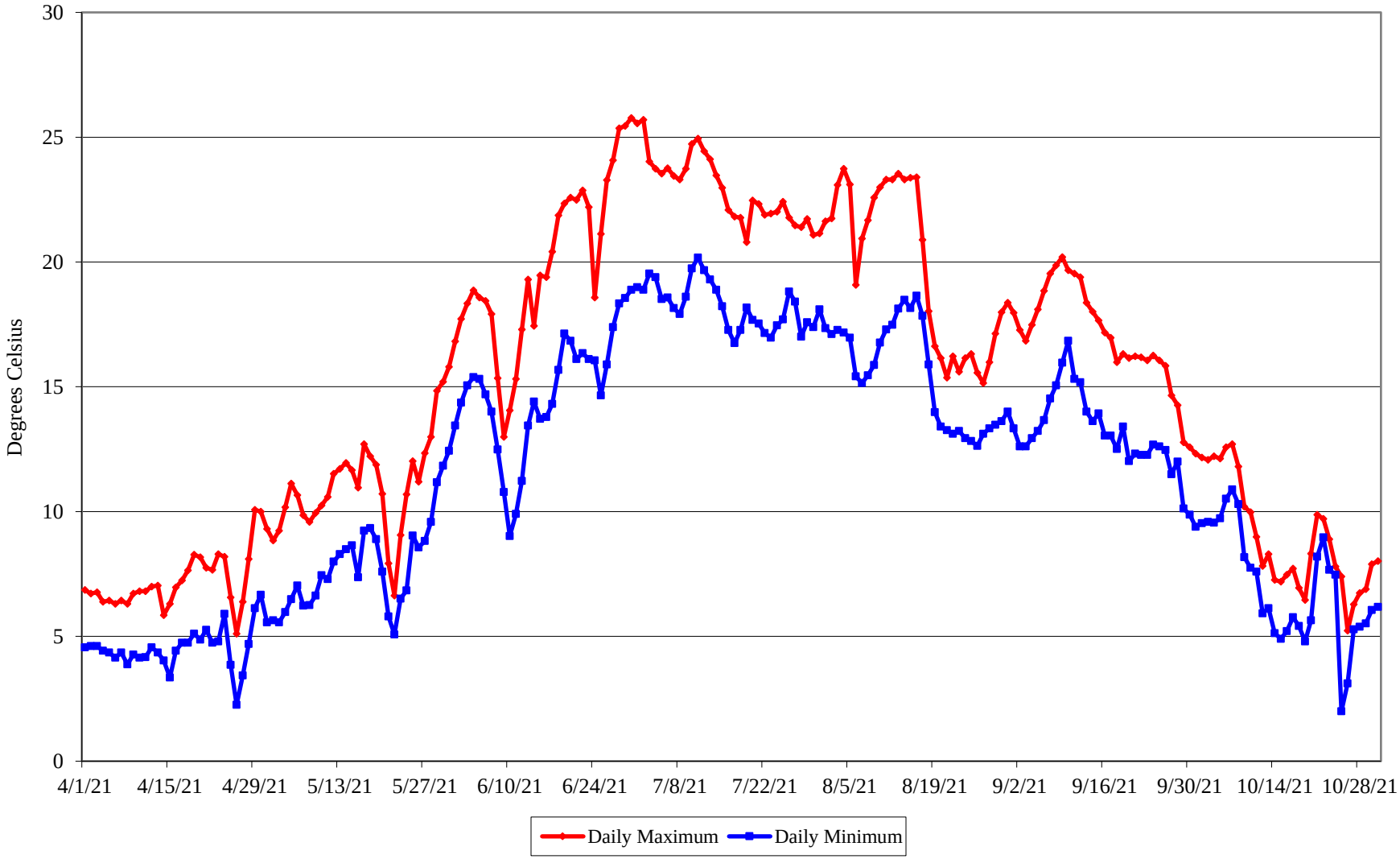

Figure 16. Daily Maximum and Minimum Water Temperatures in South Fork American above Silver Fork American River (T8)

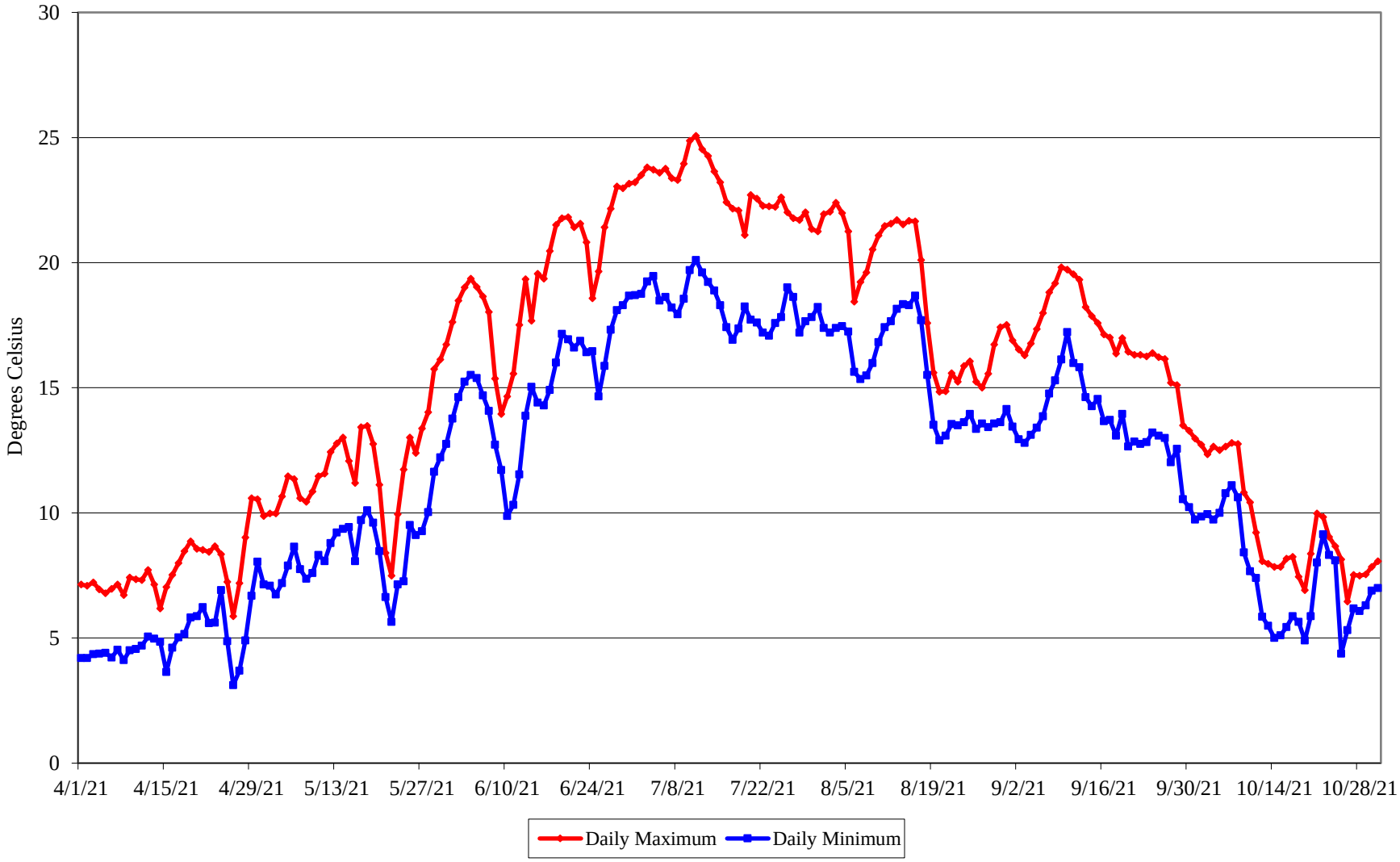

Figure 17. Daily Maximum and Minimum Water Temperatures in South Fork American River above Kyburz Diversion (T26)

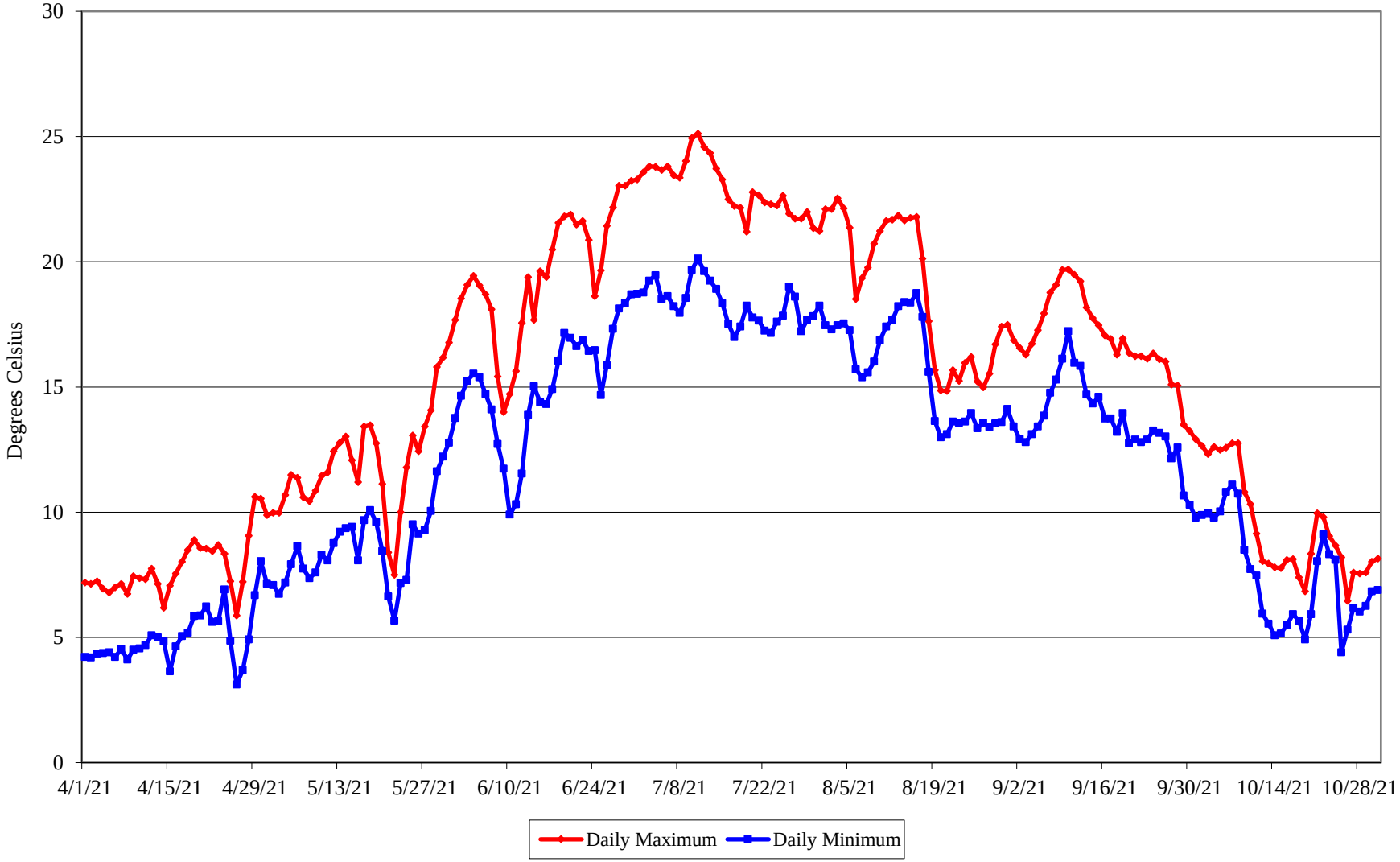

Figure 18. Daily Maximum and Minimum Water Temperatures in South Fork American River below Kyburz Diversion (T9)

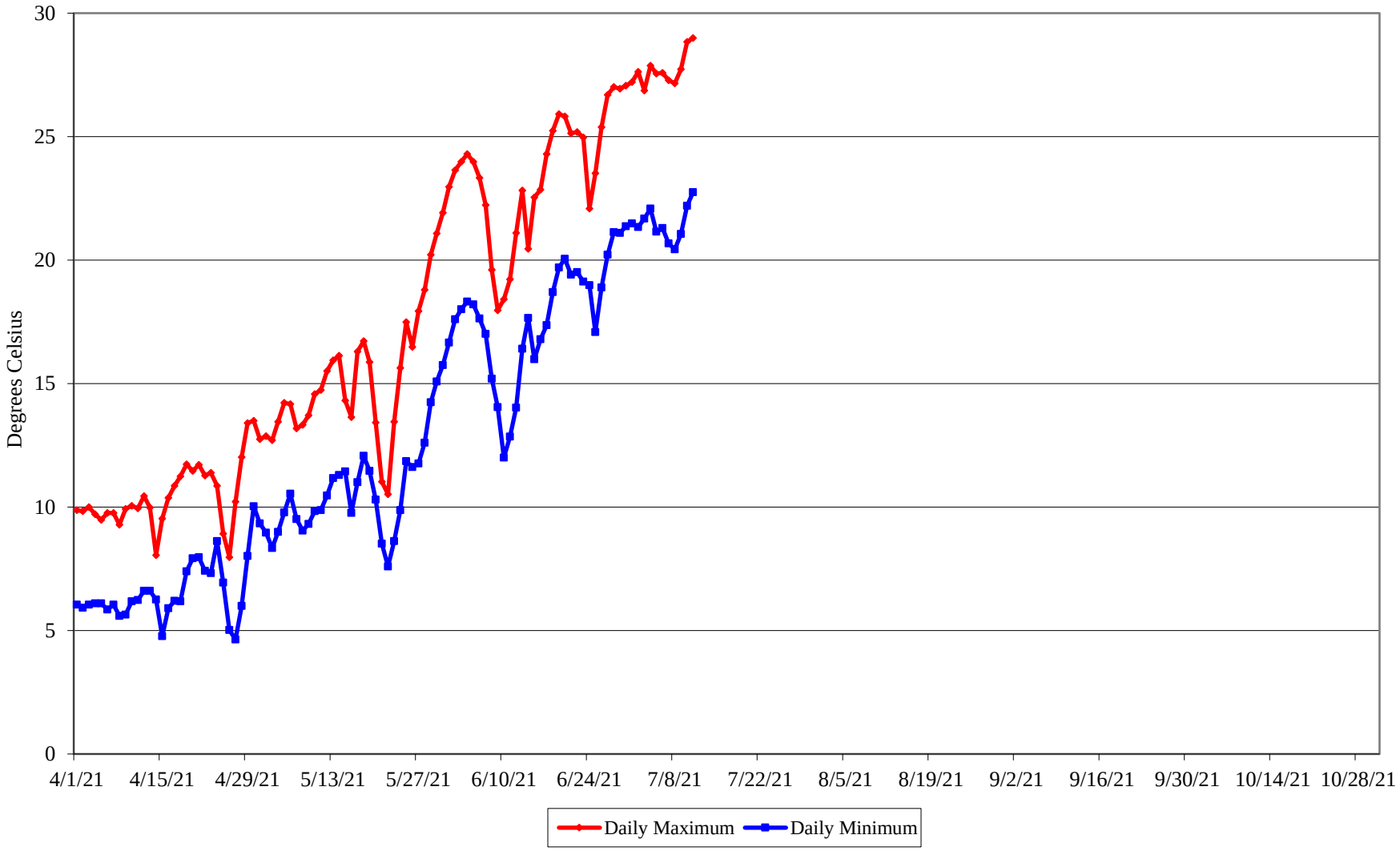

Figure 19. Daily Maximum and Minimum Water Temperatures in South Fork American River near Bridal Veil Picnic Area (T25)

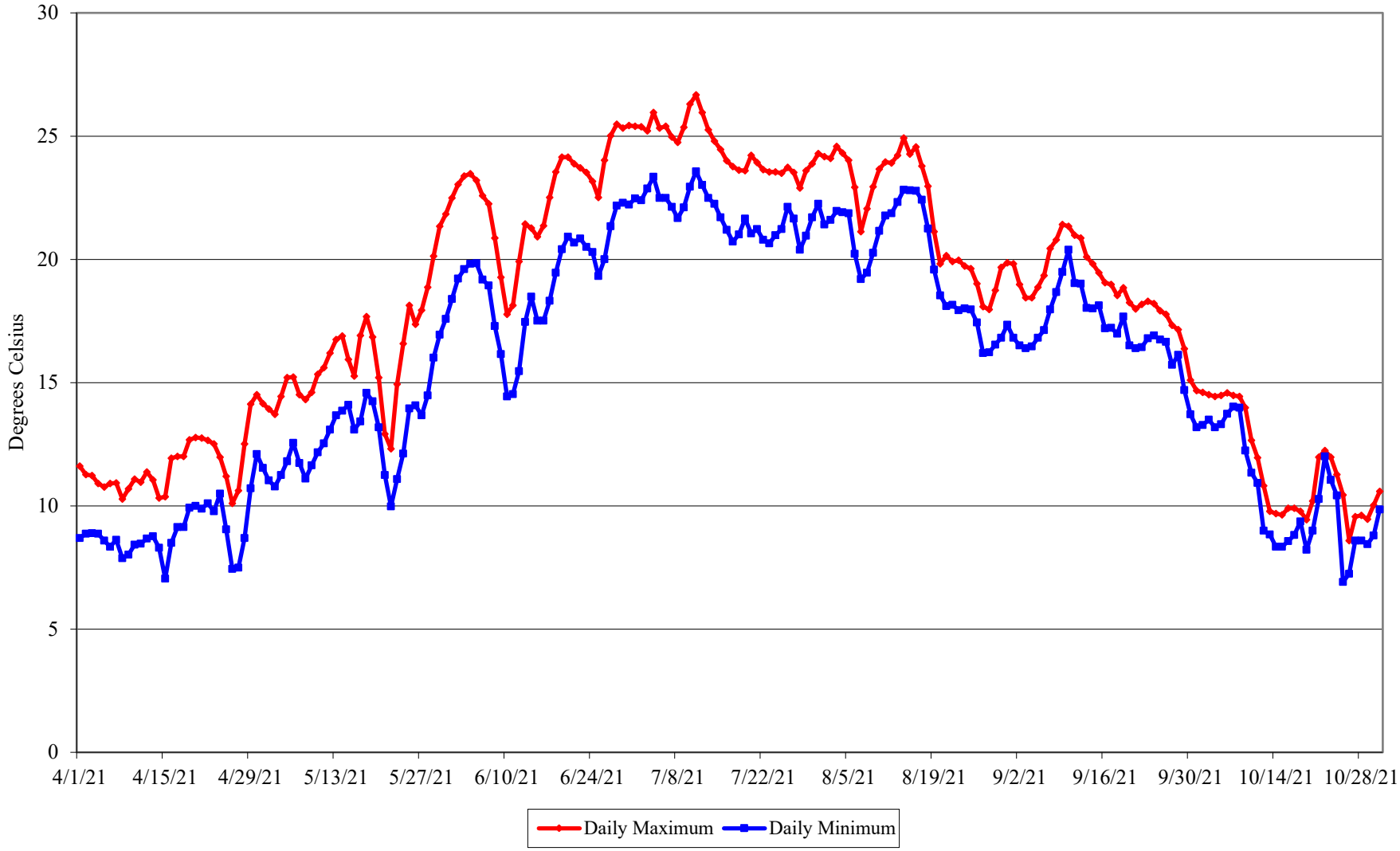

Figure 20. Daily Maximum and Minimum Water Temperatures in South Fork American River above Akin Powerhouse (T10)

Appendix B:

Spreadsheet data: 2021 Hourly, Daily Mean, Daily Maximum, and Daily Minimum Water Temperatures

https://www.eid.org/our-services/hydroelectric/project-184/project-184-document-library